

pH/ORP Sensor



ESSENTIAL INSTRUCTIONS

READ THIS PAGE BEFORE PROCEEDING!

Rosemount Analytical designs, manufactures, and tests its products to meet many national and international standards. Because these instruments are sophisticated technical products, you must properly install, use, and maintain them to ensure they continue to operate within their normal specifications. The following instructions must be adhered to and integrated into your safety program when installing, using, and maintaining Rosemount Analytical products. Failure to follow the proper instructions may cause any one of the following situations to occur: Loss of life; personal injury; property damage; damage to this instrument; and warranty invalidation.

- Read all instructions prior to installing, operating, and servicing the product. If this Instruction Manual is not the correct manual, telephone 1-800-654-7768 and the requested manual will be provided. Save this Instruction Manual for future reference.
- If you do not understand any of the instructions, contact your Rosemount representative for clarification.
- Follow all warnings, cautions, and instructions marked on and supplied with the product.
- Inform and educate your personnel in the proper installation, operation, and maintenance of the product.
- Install your equipment as specified in the Installation Instructions of the appropriate Instruction Manual and per applicable local and national codes. Connect all products to the proper electrical and pressure sources.
- To ensure proper performance, use qualified personnel to install, operate, update, program, and maintain the product.
- When replacement parts are required, ensure that qualified people use replacement parts specified by Rosemount. Unauthorized parts and procedures can affect the product's performance and place the safe operation of your process at risk. Look alike substitutions may result in fire, electrical hazards, or improper operation.
- Ensure that all equipment doors are closed and protective covers are in place, except when maintenance is being performed by qualified persons, to prevent electrical shock and personal injury.

DANGER

HAZARDOUS AREA INSTALLATION

Installations near flammable liquids or in hazardous area locations must be carefully evaluated by qualified on site safety personnel. This sensor is not Intrinsically Safe or Explosion Proof.

To secure and maintain an intrinsically safe installation, the certified safety barrier, transmitter, and sensor combination must be used. The installation system must comply with the governing approval agency (FM, CSA or BASEEFA/CENELEC) hazardous area classification requirements. Consult your analyzer/transmitter instruction manual for details.

Proper installation, operation and servicing of this sensor in a Hazardous Area Installation is entirely the responsibility of the user.

CAUTION

SENSOR/PROCESS APPLICATION COMPATIBILITY

The wetted sensor materials may not be compatible with process composition and operating conditions. Application compatibility is entirely the responsibility of the user.

Emerson Process Management

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MODEL 381 pH/ORP SENSOR

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About This Document

This manual contains instructions for installation and operation of the Model 381 pH/ORP Sensor.

The following list provides notes concerning all revisions of this document.

<u>Rev. Level</u>	<u>Date</u>	<u>Notes</u>
A	6/94-1/00	This is the initial release of the product manual. The manual has been reformatted to reflect the Emerson documentation style and updated to reflect any changes in the product offering.
B	5/02	Updated multiple drawings throughout manual.
C	3/05	Updates
D	10/07	Updated page 3 code 00 insertion is no longer available.

SECTION 1.0

DESCRIPTION AND SPECIFICATIONS

- MOLDED POLYETHERSULFONE (PES) BODY provides compatibility with a variety of processes.
- MODULAR DESIGN facilitates maintenance by eliminating terminal and mounting brackets and extraneous hardware.
- INTEGRAL PREAMPLIFIER provides reliable signal transmission.
- DOUBLE JUNCTION, GEL-FILLED, REFERENCE CELL provides high temperature performance, extended service life, and resists the effects of pumping, dilution and contamination.
- OPTIONAL FLOW-POWERED OR ULTRASONIC CLEANING provides trouble-free service in difficult applications.

1.1 FEATURES AND APPLICATIONS

The Model 381 Sensor measures the pH or the Oxidation Reduction Potential (ORP) of aqueous solutions in pipelines, open tanks or ponds. The sensor is used in most industrial applications including SO₂ scrubbers, rinse tanks, plating baths, reverse osmosis units, and water and waste treatment plants.

The sensor is housed in a molded PES body and has two O-ring seals with breach lock threads which secure the PES cover. This provides a waterproof union for long operating life and easy removal for routine maintenance.

The modular body design eliminates the need for internal mounting brackets, terminal brackets and screws. All components are screw-type or plug-in-place, allowing for fast simple service.

The integral preamplifier amplifies the high impedance glass electrode signal at the sensor, providing a transmission capability of up to three miles. The Rosemount Analytical Inc. method of preamplification has become the industry standard for reliable pH measurement. In submersion applications at temperatures greater than 80°C, the preamplifier must be located in a remote junction box.

A standard feature of the Model 381 is the double junction, gel-filled reference cell which reduces the need for special applications engineering where unknown reference cell contamination, such as sulfides, may exist. The gel solution maintains its viscosi-

ty at high temperatures, and resists the effect of pumping and dilution, resulting in an extended service life. A choice of wood (Code 20) or ceramic (Code 21) liquid junction is available to provide resistance to fouling and subsequent loss of electrical contact between the reference electrode and process fluid.

In flow applications where crystalline or viscous coatings, such as calcium carbonate or petroleum oils, may coat the electrode surfaces and impede the sensor's performance, the flow-powered cleaning option (Code 04) may be used. A specially designed flow chamber directs the process fluid in a circular path carrying three Teflon¹ balls which clean the electrode surface, physically preventing accumulation of coating materials. Flow-powered cleaning is suitable for all hazardous area applications.

In submersion (Code 02) applications, the ultrasonic cleaning option may be specified. This assembly includes the ultrasonic transducer and generator, mounting hardware, and 20 ft. of interconnection cable. Ultrasonic cleaning is not suitable for hazardous area applications.

The Model 381 is compatible with all Rosemount Analytical pH/ORP analyzers. For use with the 1054/2054 Series, 2081 and other pH analyzers which utilize a PT-100 automatic temperature compensator order the Model 381 pHE.

¹ Teflon is a registered trademark of E.I. du Pont de Nemours & Co.

1.2 SENSOR SPECIFICATIONS**Materials of Construction:**

Body, Cover and Flow Cell: Polyethersulfone (PES).
O-Rings: Viton².

Measuring Electrode: Glass (and platinum for Model 381 ORP).

Liquid Junction: Kynar³/wood (Code 20) or
Kynar/ceramic (Code 21).

Process Connections: Submersion: 3/4 inch MNPT.

Insertion: 2 inch MNPT.

Flow Through: 3/4 inch MNPT.

Dimensions: (see Figure 1-1).

Measuring Range: pH 0-14
ORP -1500mV to +1500mV

Temperature Compensation: (Model 381 pH only,
not required for Model 381 ORP).
Automatic, 0 to 100°C (32 to 212°F).

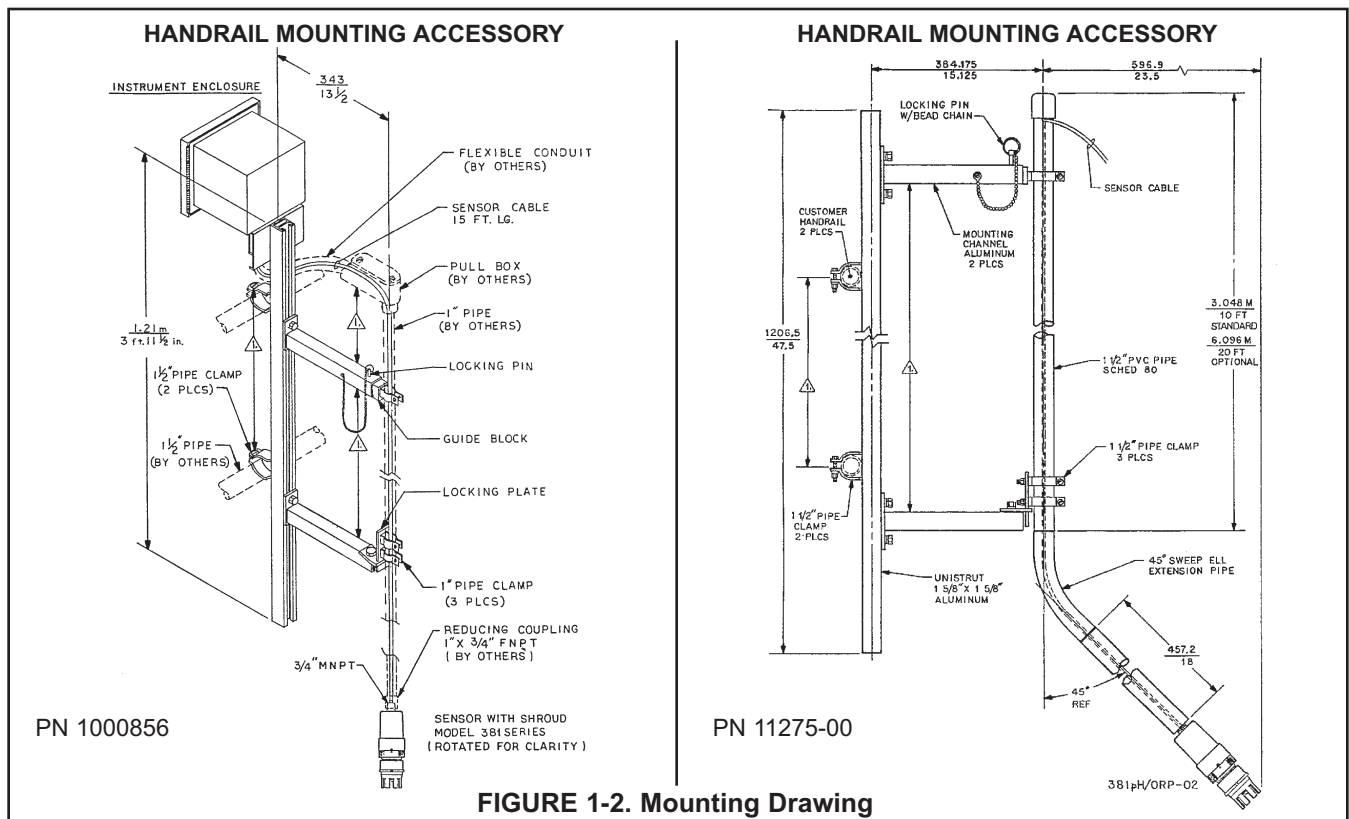
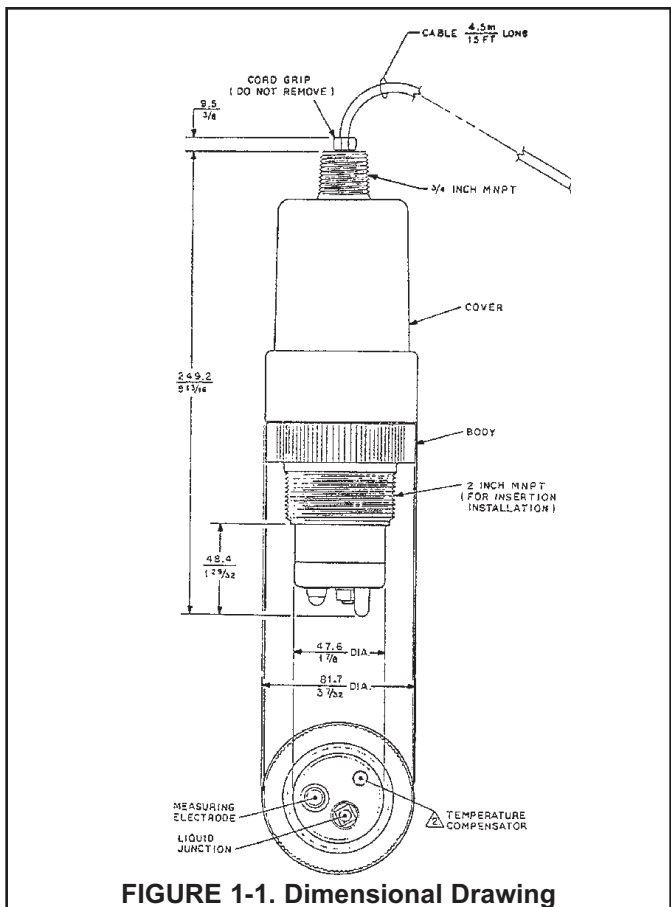
Pressure Rating: 790 kPa abs at 100°C
(100 psig at 212°F)

Cable: Four-conductor, 22 GA, each (0.64 mm dia.),
with common shield.

Weight/Shipping Weight: 1.0 kg/1.7 kg (2.2 lb./ 3.7 lb.).

² Viton is a registered trademark of E.I. du Pont de Nemours & Co.

³ Kynar is a trademark of Elf Atochem North America, Inc.



1.3 ORDERING INFORMATION Model pH/ORP Sensor is housed in a PES body suitable for insertion, submersion or flow through installation. The sensor includes an integral preamplifier, measuring electrode, double junction gel-filled reference cell, automatic temperature compensation for pH, and a choice of two cable lengths of either 15 ft. or 50 ft. (4.5 or 15.2 m).

MODEL 381 INSERTION, SUBMERSION, FLOW THROUGH SENSOR									
	CODE FUNCTION								
	pH	Requires Code 30							
	ORP	Requires Code 32 (not for use with 1054/1054A ORP Series)							
	pHE	Requires Code 31 (for use with 1054/1054A/2054 Series and 2081)							
	CODE INSTALLATION								
	02	Submersion							
	03	Flow Through							
	04	Flow Through with Flow Powered Cleaner (not available with ORP)							
	CODE MEASURING ELECTRODE								
	10	General purpose pH							
	11	High pH Electrode. requires Code 21. For sodium concentrations greater than 1% or continuous measurement above 11 pH.							
	12	Ruggedized pH Electrode. For abrasive solutions.							
	13	Platinum ORP Electrode.							
	14	Gold ORP Electrode.							
	CODE LIQUID JUNCTION								
	20	Wood/KYNAR Liquid Junction							
	21	Ceramic/KYNAR Liquid Junction							
	CODE TEMPERATURE COMPENSATION								
	30	Automatic T.C., 3.0K ohm. For Models 1003, 1050 & 1181 pH							
	31	Automatic T.C., PT-100. For Models 1054/2054 Series, and 2081							
	CODE CABLE								
	40	15 ft. cable for integral sensor preamp							
	41	15 ft. coax cable w/BNC connector for remote sensor preamp and integral analyzer preamp (1054A-54/2054-54 only)							
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	43	50 ft. cable for integral sensor preamp							
	CODE INTEGRAL PREAMPLIFIER								
	50	Preamp for Models 1181 pH/ORP & 1050/1060							
	51	Preamp for Models 1003/1023							
	CODE CABLE								
	42	15 ft. coax cable w/o BNC connector for integral analyzer preamp (1054, 1181-43/44 & 2081-05 only)							
	43	50 ft. cable for integral sensor preamp							
	CODE INTEGRAL PREAMPLIFIER								
	50	Preamp for Models 1181 pH/ORP & 1050/1060							
	51	Preamp for Models 1003/1023							
	CODE CABLE								
	42	15 ft. coax cable w/o BNC connector for integral analyzer preamp (1054, 1181-43/44 & 2081-05 only)							
	43	50 ft. cable for integral sensor preamp							
	CODE INTEGRAL PREAMPLIFIER								
	50	Preamp for Models 1181 pH/ORP & 1050/1060							
	51	Preamp for Models 1003/1023							
	CODE CABLE								
	42	15 ft. coax cable w/o BNC connector for integral analyzer preamp (1054, 1181-43/44 & 2081-05 only)							
	43	50 ft. cable for integral sensor preamp							
	CODE INTEGRAL PREAMPLIFIER								
	50	Preamp for Models 1181 pH/ORP & 1050/1060							
	51	Preamp for Models 1003/1023							
	CODE CABLE								
	42	15 ft. coax cable w/o BNC connector for integral analyzer preamp (1054, 1181-43/44 & 2081-05 only)							
	43	50 ft. cable for integral sensor preamp							
	CODE INTEGRAL PREAMPLIFIER								
	50	Preamp for Models 1181 pH/ORP & 1050/1060							
	51	Preamp for Models 1003/1023							
	CODE CABLE								
	42	15 ft. coax cable w/o BNC connector for integral analyzer preamp (1054, 1181-43/44 & 2081-05 only)							
	43	50 ft. cable for integral sensor preamp							
	CODE INTEGRAL PREAMPLIFIER								
	50	Preamp for Models 1181 pH/ORP & 1050/1060							
	51	Preamp for Models 1003/1023							
	CODE CABLE								
	42	15 ft. coax cable w/o BNC connector for integral analyzer preamp (1054, 1181-43/44 & 2081-05 only)							
	43	50 ft. cable for integral sensor preamp							
	CODE INTEGRAL PREAMPLIFIER								
	50	Preamp for Models 1181 pH/ORP & 1050/1060							
	51	Preamp for Models 1003/1023							
	CODE CABLE								
	42	15 ft. coax cable w/o BNC connector for integral analyzer preamp (1054, 1181-43/44 & 2081-05 only)							
	43	50 ft. cable for integral sensor preamp							
	CODE INTEGRAL PREAMPLIFIER								
	50	Preamp for Models 1181 pH/ORP & 1050/1060							
	51	Preamp for Models 1003/1023							
	CODE CABLE								
	42	15 ft. coax cable w/o BNC connector for integral analyzer preamp (1054, 1181-43/44 & 2081-05 only)							
	43	50 ft. cable for integral sensor preamp							
	CODE INTEGRAL PREAMPLIFIER								
	50	Preamp for Models 1181 pH/ORP & 1050/1060							
	51	Preamp for Models 1003/1023							
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	CODE INTEGRAL PREAMPLIFIER								
	50	Preamp for Models 1181 pH/ORP & 1050/1060							
	51	Preamp for Models 1003/1023							
	CODE CABLE								
	42	15 ft. coax cable w/o BNC connector for integral analyzer preamp (1054, 1181-43/44 & 2081-05 only)							
	43	50 ft. cable for integral sensor preamp							
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	50	Preamp for Models 1181 pH/ORP & 1050/1060							
	51	Preamp for Models 1003/1023							
	CODE CABLE								
	42	15 ft. coax cable w/o BNC connector for integral analyzer preamp (1054, 1181-43/44 & 2081-05 only)							

SECTION 2.0 INSTALLATION

2.1 INSTALLATION. Prepare the sensor for installation as follows (see Figure 2-1):

1. Remove the cover from the body by grasping the body and rotating the cover 1/4 turn counter-clockwise.
2. When the cover breaks loose from the body, pull the cover straight out.
3. Lubricate the seals of the glass electrode with O-ring lubricant, Rosemount Analytical P/N 2001928, and install the glass electrode in the body. Tighten the electrode nut by hand. DO NOT use tools.

CAUTION

Do not get lubricant on amber tip of glass electrode. It will disrupt the electrical circuit path.

4. Make sure the double junction electrode is threaded tightly.
5. Plug the preamplifier (or remote connector) onto the T.C. and reference electrode pins.
6. Connect the BNC connector from the glass electrode to the preamplifier.
7. Install the body O-rings. Make sure they are clean, and not twisted. Make sure the covers mating surfaces are clean.

NOTE

Both body O-rings must be installed and lubricated to ensure a water tight seal. Failure to seal the body properly will result in water damage, in insertion applications.

8. Lubricate the body O-rings with O-ring lubricant, P/N 2001928.
9. Plug the cable connector to the preamplifier, making sure the cable is toward the center of the body.
10. Install the cover on the body so that the threads will engage.
11. Rotate the cover until the triangle on the body aligns with (or falls within) the adjacent mark on the cover.

IMPORTANT!

12. While holding the sensor in an up side down position (see Figure 2-1), remove the 1/4 inch plug from the electrode tip end of the sensor.
13. Install the liquid junction in place of the 1/4 inch plug, using Teflon tape on the liquid junction threads.

CAUTION

DO NOT use pipe joint compound or pipe dope on the threads of the liquid junction. The electrical circuit will be disrupted if the liquid junction is contaminated.

2.2 SUBMERSION INSTALLATION (Code 02). To install the sensor in process proceed as follows (see Figure 2-2):

1. Wrap Teflon tape on 3/4 inch MNPT threads of cover and on standpipe threads. Seal must be water tight. Cable gland is not waterproof. Do not allow water to accumulate in the stand pipe.

CAUTION

Do not use a pipe wrench on the plastic parts. Severe damage could result.

2. Attach a 3/4 inch coupling to the sensor.
3. Attach electrode shroud to 2 inch MNPT.
4. Feed cable through the rigid standpipe.
5. Attach the rigid standpipe to 1 inch coupling.

CAUTION

Rigid stand pipe must be water-tight; cable seal is not waterproof.

6. Tighten all fittings and secure the standpipe to minimize sensor movement. Use flexible conduit at the top of the rigid standpipe to permit removal of the sensor for periodic maintenance.
7. Refer to Section 2.6 and wire the sensor to the transmitter as described.

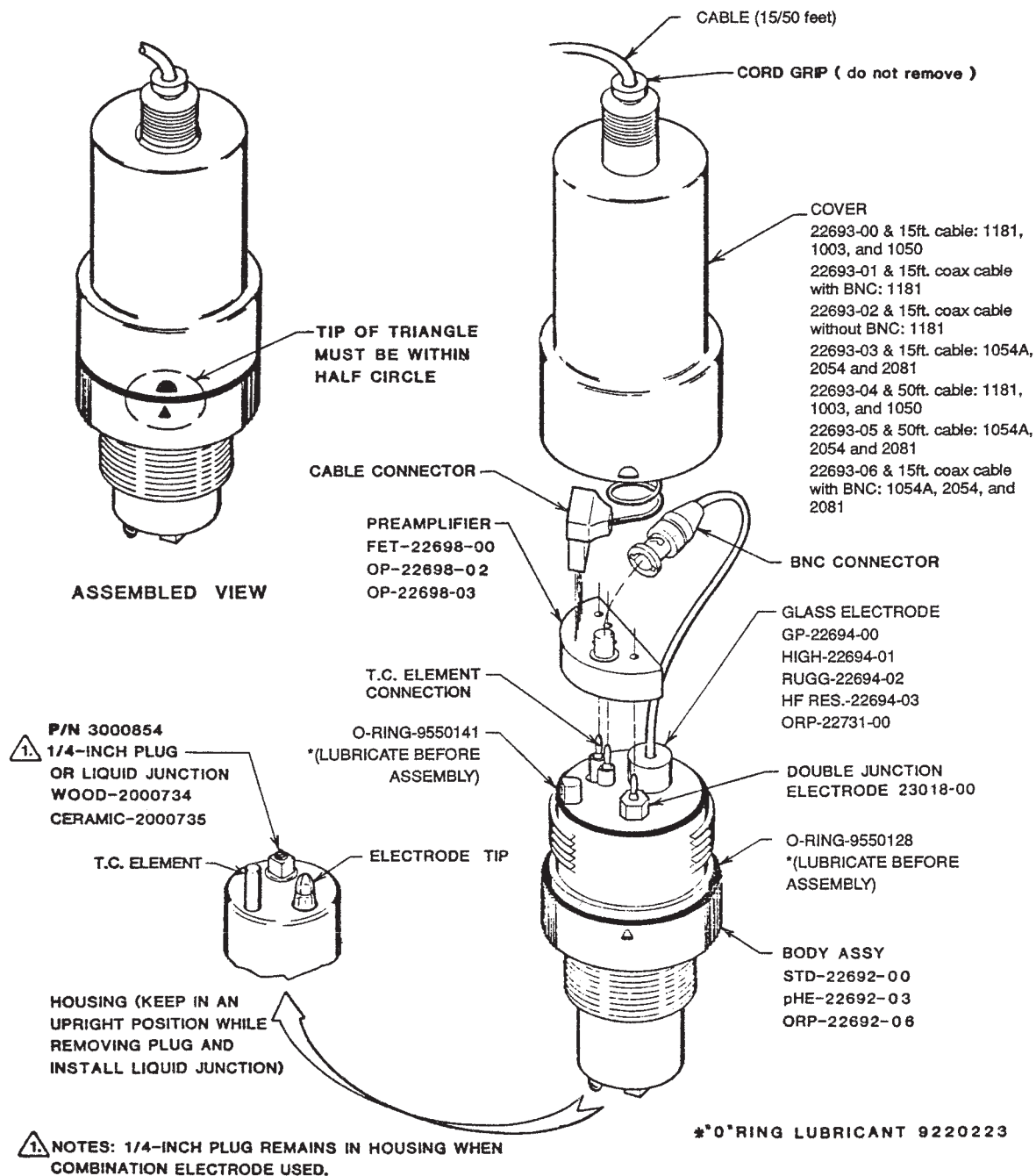


FIGURE 2-1. Model 381 Sensor Component Locator Diagram

2.3 INSERTION INSTALLATION (Code 00). To install the sensor in the side of a tank, in a pipeline, or in a pipe “tee”, proceed as follows (see Figure 2-3):

CAUTION

Sensor must be installed within 80° of the vertical plane (see Figure 2-3).

1. Use Teflon tape on pipe joint, and install sensor as shown in Figure 2-3.

CAUTION

Do not use a pipe wrench on the plastic sensor parts. Severe damage could result.

2. Tighten all fittings and sensor.
3. Refer to Section 2.6 for wiring instructions.
4. If desired, the cable may be installed in a conduit. Flexible conduit **MUST** be used at the sensor for a short distance to permit removal for periodic maintenance. Use the 3/4 inch MNPT threads on the cover to attach the conduit to the sensor.

2.4 FLOW THROUGH INSTALLATION (Code 03). To install the sensor in the flow cell proceed as follows (see Figure 2-4):

1. Attach the flow cell's 3/4 inch MNPT to the sample or process line. (Note flow direction on side of flow cell.)
2. Holding the sensor with the electrode pointing up, seat the upper O-ring (P/N 9550146) flush with the sensor body above the 2-inch MNPT. Lubricate with O-ring lubricant (P/N 2001928).
3. With the coupling nut thread in place, thread the electrode shroud onto the sensor body (see Figure 2-4), insuring that the O-ring is properly seated and does not become pinched or twisted.

NOTE

The coupling nut must be inserted between the lower body assembly of the sensor and electrode shroud (see Figure 2-4).

4. Next, place the lower O-ring (P/N 9550147) in the flow cell and lubricate with O-ring lubricant (P/N 2001928).
5. Place sensor, coupling nut and electrode shroud in the flow cell. Insure that the O-ring is seated properly.
6. Rotate sensor until the key on electrode shroud drops into either the “open-flow” or “guarded” flow* position.
7. Tighten the coupling nut and the flow cell fittings.

NOTE

Electrode shroud and coupling nut should be hand tightened only. Do not use a wrench. When tightening process or sample line connectors to the flow cell do not use a pipe wrench on the flow cell. Severe damage may result.

* In “guarded” flow position, solid particles in the flow stream are diverted from electrode.

2.4.1 Installation Procedures For Low Flow Conditions. It is extremely important that the measuring electrode and liquid junction of any pH/ORP sensor remain in contact with the process fluid at all times.

Under low flow conditions or where flow fluctuations are common, sensor contact with the process fluid may be interrupted unless piping procedures are followed to prevent it.

A customer supplied valve should be installed to eliminate head pressure when the sensor is being removed from the process. This valve may also serve as a grab sample take-off point.

The installation drawing (Figure 2-5) shows the recommended piping procedures for the Model 381 pH/ORP sensor in low flow conditions.

2.5 FLOW POWERED CLEANER INSTALLATION (Code 04). To install the sensor in a flow cell with flow powered cleaner, proceed as follows (see Figure 2-6):

1. Attach the flow cell's 3/4 inch MNPT to sample or process line. Note flow direction shown on the side of the flow cell.
2. Insert the ring as shown in Figure 2-6. It should snap in place.
3. Place the chamber into the flow cell. Notch must be aligned for the chamber to go in place. Place the Teflon balls (4 each) in the chamber.
4. Follow Steps 2 through 7 in Section 2.4 for sensor installation into flow assembly (see Figure 2-4).

2.6 WIRING. Connect the wire lugs to the transmitter terminals as shown in Figures 2-7 thru 2-10.

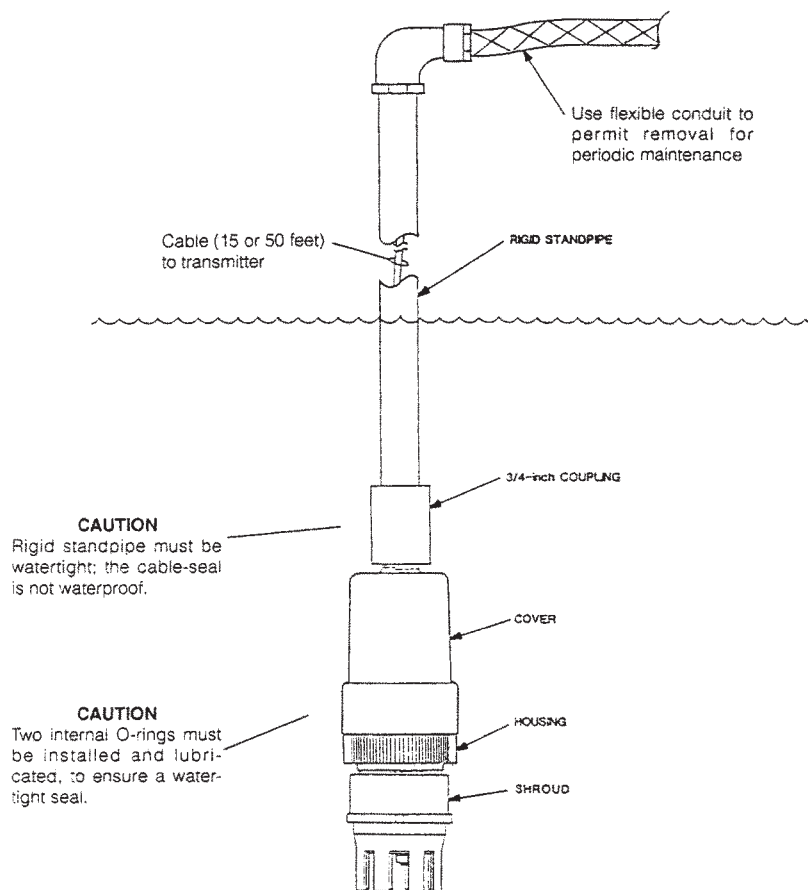


FIGURE 2-2. Submersion Installation Diagram

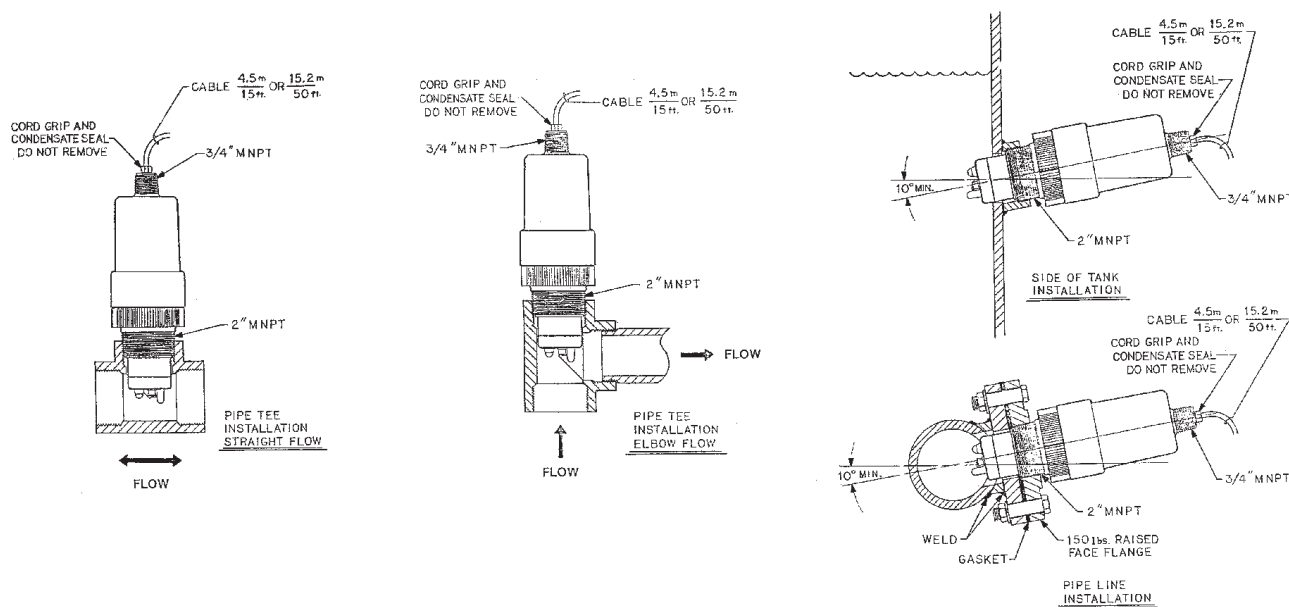


FIGURE 2-3. Insertion Installation Diagram

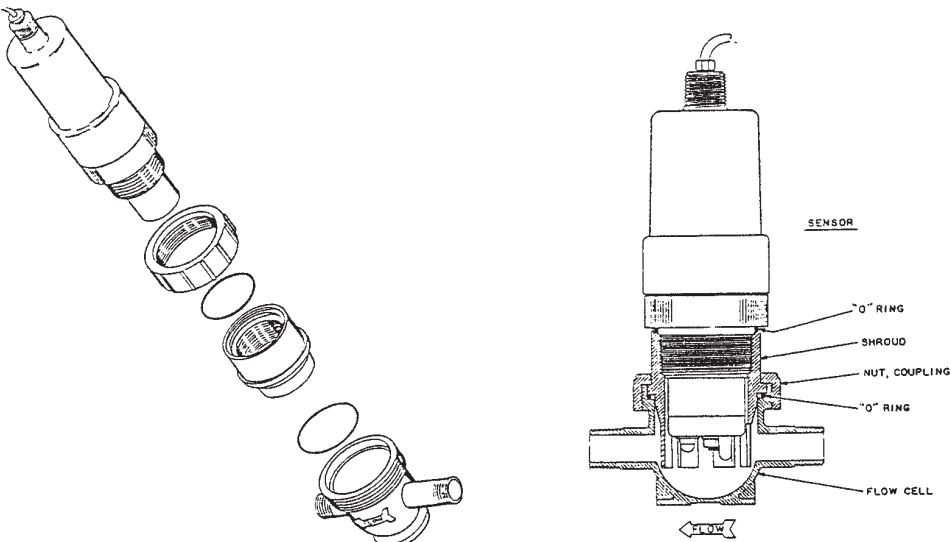


FIGURE 2-4. Flow Through Installation Diagram (Code 03 or 04)

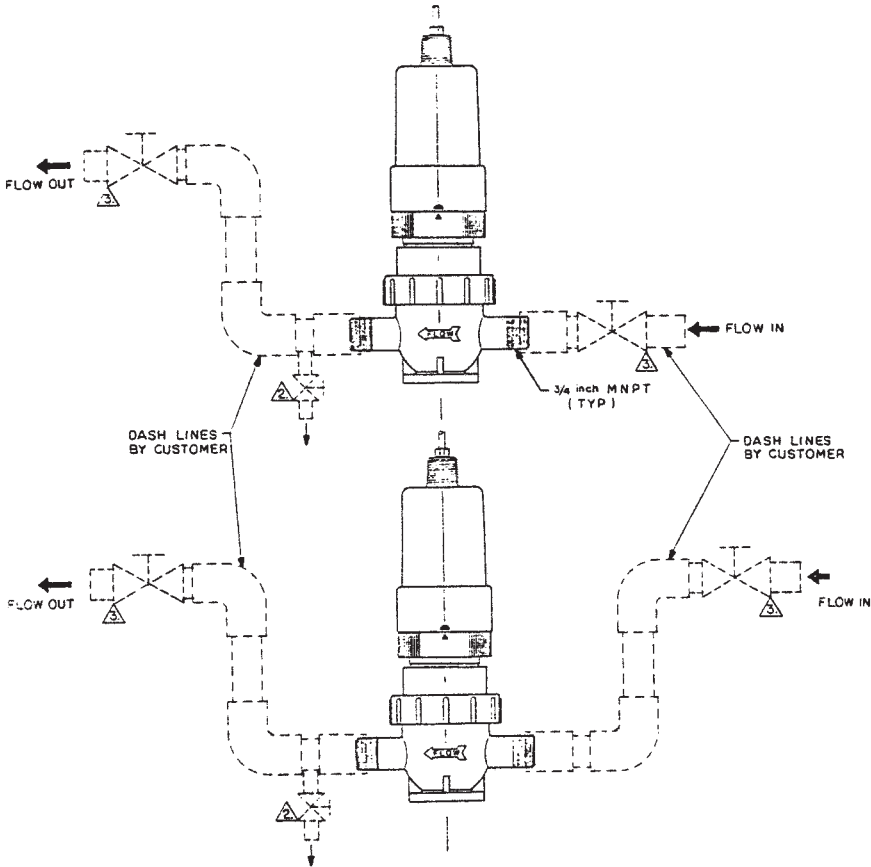
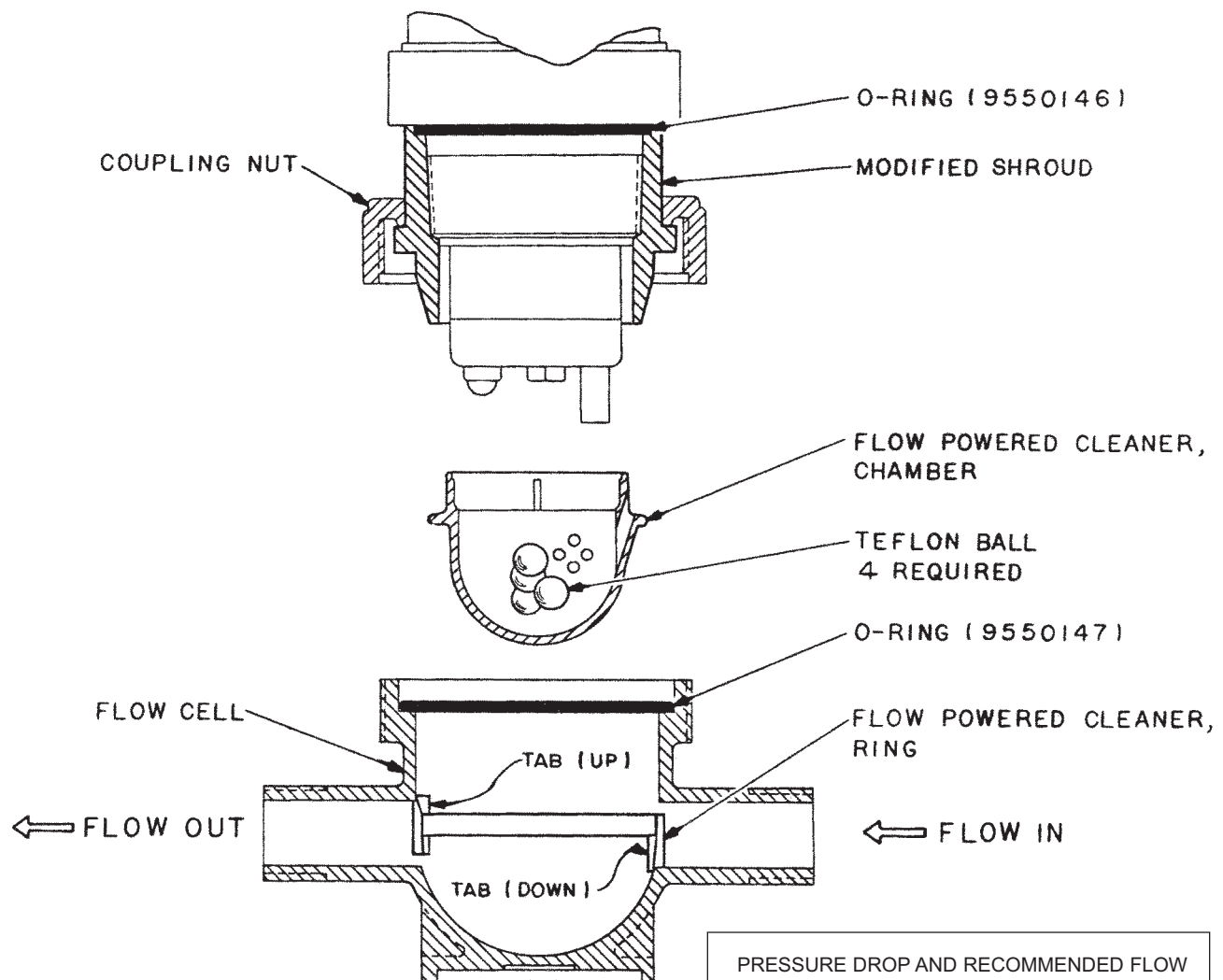


FIGURE 2-5. Installation Details Low Flow Conditions Model 381 (Code 03 and 04)



PART NO.	QTY	DESCRIPTION	RETRO-FIT KIT	(-04) OPTION
			22692-00	22811-01
2001928	1	LUB, O-RING	X	X
22723-00	1	KIT, BALLS CLEANER	X	X
32602-00	1	FLOW CELL		X
32606-00	1	NUT, COUPLING		X
32792-00	1	SHROUD, MODIFIED	X	X
32793-00	1	RING	X	X
32794-00	1	CHAMBER	X	X
9550146	1	O-RING 2-229 VITON	X	X
9550147	1	O-RING 2-232 VITON	X	X

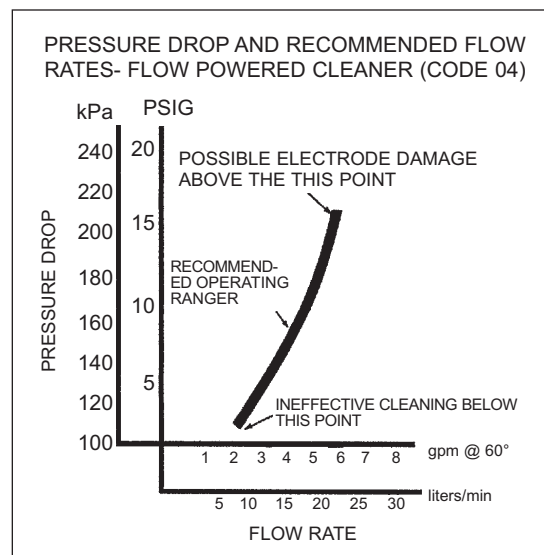
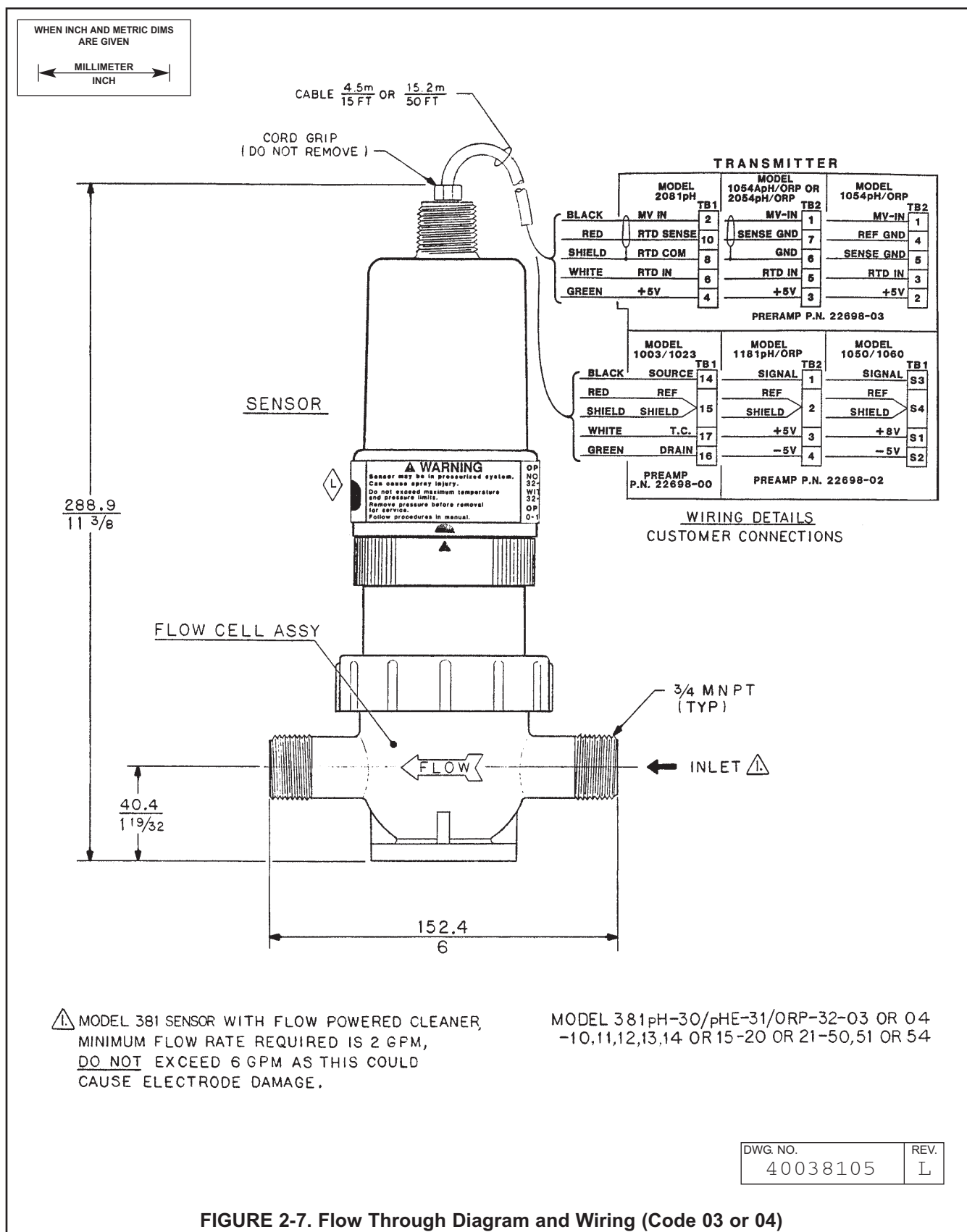


FIGURE 2-6. Retro-Fit Kit Code 04 Flow Powered Cleaner, Model 381



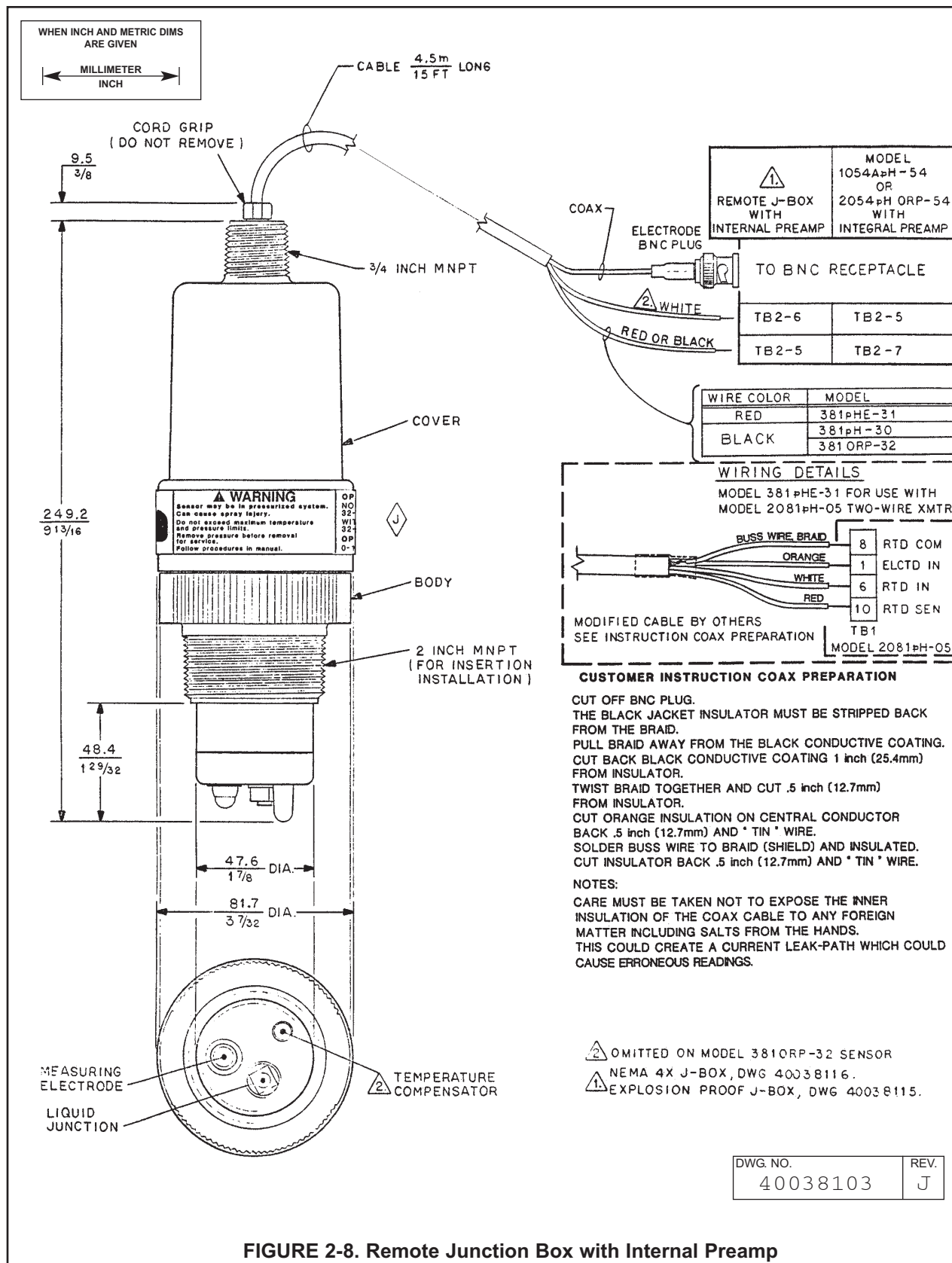
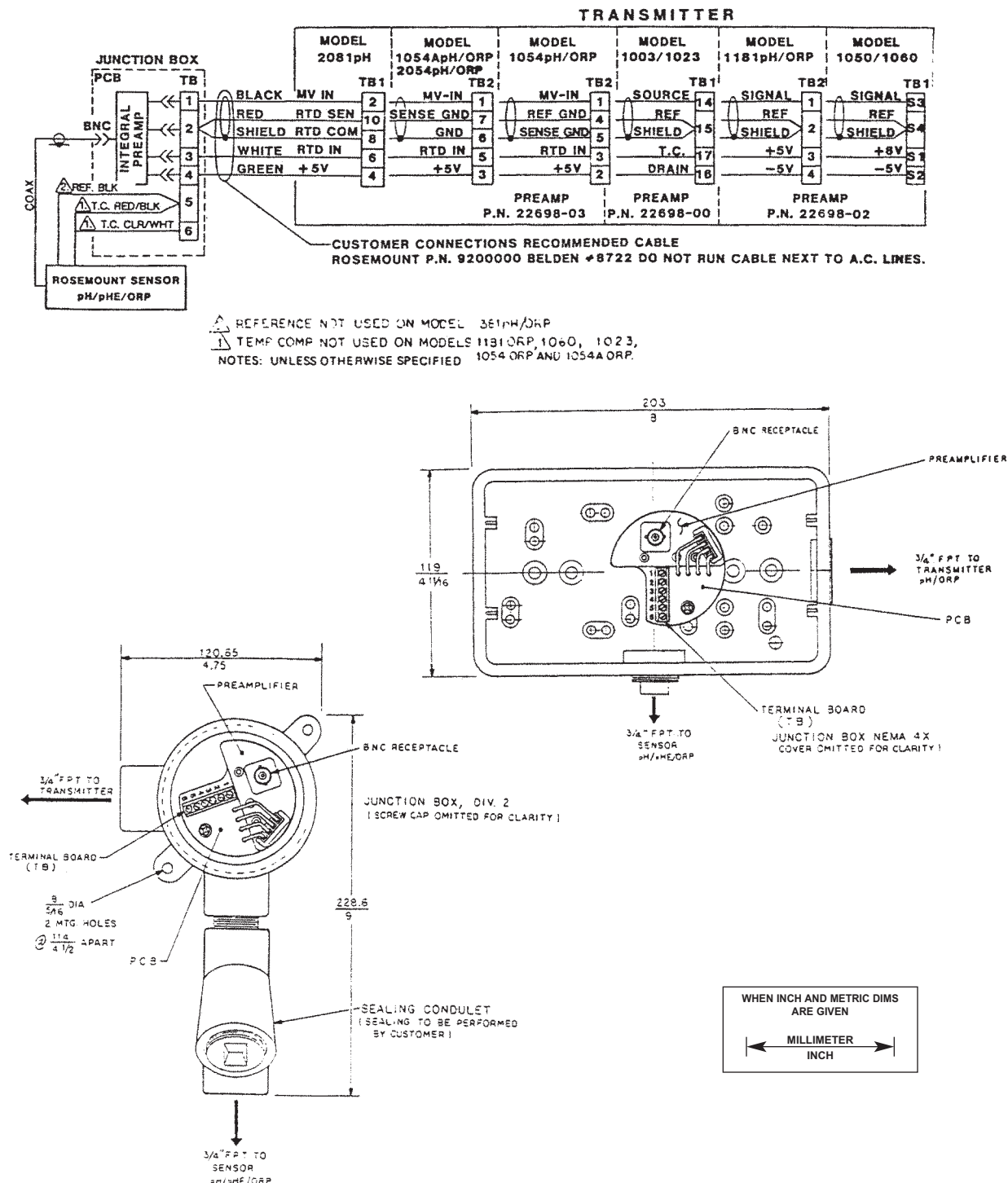


FIGURE 2-8. Remote Junction Box with Internal Preamp



DWG. NO. 40038116
REV. I

DWG. NO. 40038115
REV. K

FIGURE 2-9. Wiring with Weatherproof or Div. 2 (Code 52) Junction Box

2.7 START-UP AND CALIBRATION**2.8 MODEL 381 pH and pHE**

2.8.1 SENSOR PREPARATION. Shake down the sensor to remove any air bubbles that may be present at the tip of the pH glass bulb. In most cases, the pH sensor can simply be installed as shipped and readings with an accuracy of ± 0.6 pH may be obtained. To obtain greater accuracy or to verify proper operation, the sensor must be calibrated as a loop with its compatible analyzer or transmitter.

WARNING

Glass electrode must be wetted at all times (in storage and in line) to maximize sensor life.

2.8.2 CALIBRATION USING BUFFER SOLUTIONS

OR GRAB SAMPLES. The pH sensor-analyzer/ transmitter loop may be calibrated by submersing the sensor in a buffer solution (standard solutions of known pH values) or in a process grab sample whose pH value maybe checked by a calibrated laboratory or portable pH meter. **Please refer to the analyzer's or the transmitter's respective instruction manuals for proper calibration procedures.**

2.9 MODEL 381 ORP.

2.9.1 MODEL 396P ORP. Most industrial applications have a number of ORP reactions occurring in sequence or simultaneously. There can be several components that are oxidized or reduced by the reagents that are used. Theoretically, the ORP potential is absolute because it is the result of the oxidation-reduction equilibrium. However, the actual measured potential is dependent on many factors, including the condition of the surface of the ORP platinum electrode. **Therefore, the sensor should be allowed 1-2 hours to become "conditioned" to the stream when first set-up or after being cleaned.**

2.9.2 Calibration**CAUTION**

The solution used during the following check is an acid and should be handled with care. Follow the directions of the acid manufacturer. Wear the proper protective equipment. Do not let the solution come in contact with skin or clothing. If contact with skin is made, immediately rinse with clean water.

1. Make a temporary electrical connection between the sensor and the instrument.
2. Obtain a standard solution of saturated quinhydrone (PN R508-160Z). This can also be made quite simply by adding a few crystals of quinhydrone to either pH 4 or pH 7 buffer. Quinhydrone is only slightly soluble therefore a few crystals will be required. (Refer to Section 4.3. for an alternate ORP standard solution).
3. Immerse the sensor in the standard solution. Allow 1-2 minutes for the ORP sensor to stabilize.
4. Adjust the standardize control of the instrument to the solution value shown in Table 2-1. The resulting potentials, measured with a clean platinum electrode and saturated KCl/AgCl reference electrode, should be within ± 20 millivolts of the value shown in Table 2-1. Solution temperature must be noted to insure accurate interpretation of results. The ORP value of saturated quinhydrone solution is not stable over long periods of time. Therefore, these standards should be made up fresh each time they are used.

TABLE 2-1.
ORP of Saturated Quinhydrone Solution
(In Millivolts)

	pH 4 Solution			pH 7 Solution		
Temp °C	20	25	30	20	25	30
Millivolt Potential	268	264	260	94	87	80

5. Remove the sensor from the buffer, rinse and install in the process.

SECTION 3.0 MAINTENANCE

3.1 GENERAL. This section provides instructions for performing periodic maintenance and for determining the cause of a malfunction (troubleshooting).

3.2 PERIODIC MAINTENANCE. The following periodic maintenance is based on operation in a water sample. Determine the schedule for the operation being maintained from past experience, or by analyzing data gathered since initial installation of the sensor.

3.2.1 Monthly. Perform the following maintenance monthly:

1. Remove the sensor from the solution or sample and observe the condition of the electrode tip.
2. If the electrode tip is coated, clean it with a soft, clean cloth or tissue moistened with a mild, non-abrasive detergent, and rinse the electrode tip with clean water. Detergents may be used to remove oil and grease coatings.
3. If Step 2 does not clean the electrode tip, remove the electrode and clean it with a dilute, 0.1 hydrochloric acid solution and rinse with clean water. HCl may be used to remove thin film and scale coatings not removed with a damp cloth or detergents.
4. Check calibration and install the sensor in the process as instructed in Section 2.0.

3.2.2 Annually. Perform the following maintenance annually (not required for combination electrode):

1. Remove the sensor from the process.
2. While holding the sensor in an upright position, remove and discard the liquid junction.
3. Drain the solution from the sensor body and rinse the inside of the body with clean, warm water.
4. Remove the cover from the body by grasping the body and rotating the cover ¼-turn in the counter-clockwise direction.
5. When the cover breaks loose from the body, pull straight out on the cover and disconnect the cable connector from the preamplifier.
6. Disconnect the electrode BNC connector from the preamplifier and then unplug the preamplifier from the body.

7. Remove and discard the double junction electrode.
8. Remove and discard the O-rings on the body.
9. Install a new double junction electrode in the body (refer to Table 3-4 Spare Parts).
10. Make sure the upper and lower body O-ring sealing surfaces are clean, and lubricate the new O-rings with O-ring lubricant (P/N 2001928). Install the O-rings making sure they are not twisted.
11. Install the preamplifier on the body and make sure all connections are secure and that both O-rings are in place.
12. Install the cover on the body so the threads will engage.
13. Rotate the cover until the triangle on the body aligns with (or falls within) the adjacent mark on the cover.

CAUTION

DO NOT use a pipe wrench on the body or cover. Severe damage could result.

14. While holding the sensor in an upright position, fill the reference chamber in the body (through the liquid junction opening) with gel solution (P/N 9210342). Care must be taken to remove as much air as possible from the reference cell.
15. Wrap Teflon tape on a new liquid junction (see Table 3-4 Spare Parts) and install the liquid junction in the body.
16. Test the sensor per Section 2.7. Install the sensor as described in Section 2.0.

NOTE

Flow-through sensor (Codes 03 & 04). Upper and lower flow cell O-rings should be replaced at this time. Lubricate new O-rings with O-ring lubricant (P/N 2001928) and reinstall sensor as described in Section 2.4. & 2.5.

3.3 MODEL 381

3.3.1 Platinum Electrode Check. The platinum electrode may be checked as follows: There are two types of standard solutions which may be used to check the ORP electrode/transmitter system.

Type 1: One type of commonly used ORP standard solution is the saturated quinhydrone solution. A commonly used ORP standard solution is a saturated quinhydrone solution. This can be made by simply adding a few quinhydrone crystals to either a 4 pH or a 7 pH buffer. Quinhydrone is only slightly soluble so only a few crystals will be required. The solution will have a yellow color. The resulting potentials should be within ± 20 millivolts of the value shown in Table 3-1. The ORP value of saturated quinhydrone solution is not stable for long periods of time and therefore new solutions should be made each time.

<p style="text-align: center;">CAUTION</p> <p>The solution used during the following check is an acid and should be handled with care. Follow the directions of the acid manufacturer. Wear the proper protective equipment. If contact with skin or clothing is made, immediately rinse with plenty of clean water.</p>

Type 2: A second ORP standard solution is the Ferric-Ferrous Ammonium Sulfate Solution (PN R508-16OZ), and it can be ordered as a spare part; otherwise, it can be prepared from the following recipe: Dissolve 39.2 grams of reagent grade ferrous ammonium sulfate, $\text{Fe}(\text{NH}_4)_2 (\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$ and 48.2 grams of reagent grade ferric ammonium sulfate, $\text{FeNH}_4(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$, in approximately 700 milliliters of water (distilled water is preferred, but tap water is acceptable).

Slowly and carefully add 56.2 milliliters of concentrated sulfuric acid. Add sufficient water to bring the total solution volume up to 1000 ml. This standard ORP solution, although not as simple to prepare as the quinhydrone recipe, is much more stable, and will maintain its millivolt value for approximately one year when stored in glass containers. This solution (ferric/ferrous ammonium sulfate) will produce a nominal ORP of 476 ± 20 mV at 25°C when used with a saturated KCl/AgCl reference electrode and platinum measuring electrode. Some tolerance in mV values is to be expected due to the rather large liquid reference junction potentials which can arise when measuring this strongly acidic and concentrated solution. However, if the measuring electrodes are kept clean and in good operating condition, consistently repeatable calibrations can be carried out using this standard solution.

3.3.2 Cleaning Platinum Electrode. The electrode is never exposed to these undesirable compounds. In the event poisoning is suspected, the electrode can be restored to normal operation by simply cleaning the platinum electrode with baking soda. Polish it by rubbing it with a damp paper towel and baking soda until a bright, shiny appearance is attained.

TABLE 3-1. ORP of Saturated Quinhydrone Solutions						
	pH 4			pH 7		
Temperature °C	20	25	30	20	25	30
Millivolt Potential	268	264	260	94	87	80

TABLE 3-1. Troubleshooting

	Trouble	Probable Cause Remedy
Meter reads off scale.	Reference electrolyte depleted.	Replace reference electrolyte as instructed in Section 3.2.2.
	Defective preamplifier.	Check preamplifier as instructed in Section 3.4 and replace preamplifier if defective.
	T.C. element shorted.	Check T.C. element as instructed in Section 3.5, and replace body if defective.
	Electrode not in solution or sample stream is not full.	Make sure sensor is in solution or that sample stream is full (refer to Section 2.0 for installation details).
	Open glass electrode.	Replace glass electrode.
	Plugged liquid junction.	Replace liquid junction. Recharge reference cell.
	Reference element open-no contact.	Replace reference element.
Meter reads between 3 and 6 pH regardless of actual pH of solution or sample.	Electrode cracked.	Replace electrode.
Meter indication swings widely in AUTO T.C. Mode.	T.C. element shorted.	Check T.C. element as instructed in Section 3.5 and replace body if defective.
Span between buffers extremely short in AUTO T.C. mode.	T.C. element open.	Check T.C. element as instructed in Section 3.5 and replace body if defective.
Sluggish or slow meter indication for real changes in pH level.	Electrode coated.	Clean electrode as instructed in Section 3.2.1.
	Electrode defective.	Replace electrode.
Transmitter cannot be standardized.	Electrode coated or cracked.	Clean electrode as instructed in Section 3.2.1 and, if cracked, replace electrode.
	Reference chamber is contaminated	Replace gel solution as instructed in Section 3.2.2.
	Defective preamplifier.	Check preamplifier as instructed in Section 3.4 and replace if defective.
	If trouble still persists, micro-junction electrode is defective.	Replace micro-junction electrode.
Meter short spans.	Old glass electrode (greater than 1 year use).	Replace electrode.
	Coated glass.	Clean with soft cloth and clean water.

3.4 PREAMPLIFIER TROUBLESHOOTING. To determine if the preamplifier is operable, proceed as follows:

1. Remove the sensor from process.
2. Remove the cover from the body by grasping the body and rotating the cover 1/4 turn in the counter-clockwise direction.
3. When the cover breaks loose from the body, pull straight out on the cover to expose the components attached to the body and disconnect the BNC connector from the preamplifier, leaving the cable connected. Inspect the internal preamplifier area for signs of moisture or corrosion; moisture can short out the preamplifier. Dry all parts thoroughly before testing.
4. Short the center pin of the BNC on the preamp-lifier to the outside of the BNC connector.
5. The meter indication should be approximately center scale (7 pH).
6. If the meter indication is not as specified in Step 5, proceed to the transmitter instruction manual for further troubleshooting. If the transmitter is operable with the preamplifier bypassed, then the preamplifier is defective.
7. Unplug the preamplifier from the body.
8. Plug a new preamplifier into the body.
9. Plug the BNC connector of the glass electrode into the preamplifier.
10. Make sure all O-rings are clean, lubricated and in place.
11. Plug the cable connector into the preamplifier, making sure the cable is towards the center of the body.
12. Install the cover on the body so that the threads engage.
13. Rotate the cover until the triangle on the body aligns with (or falls within) the adjacent mark on the cover.

CAUTION

DO NOT use a pipe wrench on the body or cover. Severe damage could result.

14. Install the sensor as described in Section 2.0.

TABLE 3-2
TEMPERATURE vs RESISTANCE OF AUTO
T.C. ELEMENT

Temperature °C	Resistance (Ohms) ± 1%	
	3K	PT-100
0	2670	100.0
10	2802	103.8
20	2934	107.7
25	3000	109.6
30	3066	111.5
40	3198	115.4
50	3330	119.2
60	3462	123.1
70	3594	126.9
80	3726	130.8
90	3858	134.6
100	3990	138.5

3.5 T Automatic Temperature Compensator. The temperature compensator element is temperature sensitive and can be checked with an ohmmeter. Resistance increases with temperature.

The 3K element will read 3000 ohms ± 1% at 25°C (77°F) and a Pt-100 will read 110 ohms. Resistance varies with temperature for a 3K and Pt-100 element and can be determined according to Table 3-2 or the following formula:

$$R_T = R_0 [1 + R_1 (T - 20)]$$

Where R_T = Resistance

T = Temperature in °C

Refer to Table 3-3 for R_0 and R_1 values

TABLE 3-3
 R_0 and R_1 VALUES FOR TEMPERATURE
COMPENSATION ELEMENTS

Temperature Compensation Element	R_0	R_1
3K	2934	.0045
PT-100	107.7	.00385

TABLE 3-4. Model 381 Spare Parts

PART NUMBER	DESCRIPTION	CODE	RECOMMENDED QUANTITY
2000734	Liquid junction wood/Kynar	20	2
2000735	Liquid junction ceramic/Kynar	21	2
2001928	O-ring lubricant	ALL	2
22692-00	Body, Uniloc standard T.C.	30	
22692-03	Body, Pt100 T.C.	31	
22692-06	Body w/o T.C.	32	
22693-00	Cover, for integral preamp, w/15 ft. cable	40	
22693-01	Cover, for remote preamp, w/15 ft. coax	41	
22693-02	Cover for remote preamp, w/15 ft. coax, no BNC	42	
22693-03	Cover, for integral preamp, w/15 ft. cable, Model 1054/2054 Series	pHE-40	
22693-04	Cover, for integral preamp w/50 ft. cable	43	
22693-05	Cover, for integral preamp, w/50 ft. cable, Model 1054/2054 Series	pHE-43	
22693-06	Cover, for remote preamp, w/15 ft. coax, w/BNC Model 1054/2054 Series	pHE-41	
22694-00	General purpose pH electrode	10	2
22694-01	High pH electrode	11	2
22694-02	Ruggedized pH electrode	12	2
22694-03	HF resistive pH electrode	15	2
22698-00	Preamplifier, Models 1003 pH and 1023 ORP	51	1
22698-02	Preamplifier, Models 1181 pH/ORP, 1050 pH/1060 ORP	50	1
22698-03	Preamplifier, Models 1054/2054 Series	54	1
22723-00	Kit, cleaning balls	04	1
22731-00	Platinum ORP electrode	13	2
22751-00	(Qty. 5) O-ring, Viton 2-037, upper body kit (9550141)	ALL	1 set
22751-01	(Qty. 5) O-ring, Viton 2-040, lower body kit (9550128)	ALL	1 set
22811-01	Retro-fit kit, flow powered cleaner	00, 02	
22892-00	Retro-fit kit, flow powered cleaner	03	
23018-00	Micro junction, reference element	ALL	2
32602-00	Flow cell	03,04	
32605-00	Electrode shroud	02, 03	
32606-00	Coupling nut	03,04	
32792-00	Shroud, modified	04	
32793-00	Ring, chamber	04	
32794-00	Chamber	04	
7900058	Gold ORP electrode	14	2
9210342	KCl Gel reference solution, 10 oz./250 ml	ALL	2
9550146	(Qty. 1) O-ring, shroud assembly	02, 03, 04	2
9550147	(Qty. 1) O-ring, flow cell assembly	03, 04	2

TABLE 3-5. Accessories

PART NUMBER	DESCRIPTION
1000856	Handrail mounting bracket for submersion service. For use with Models 1003 & 1023.
1000857	Handrail mounting bracket for submersion service. For use with remote NEMA 4X junction box.
23296-00	Remote Division 2 junction box for internal preamp for use with Models 1181pH/ORP, 1050/1060, 1003/1023
23296-01	Remote Division 2 junction box for internal preamp for use with Models 1054/1054A/2054pH ORP/2081pH.
22996-00	Remote weatherproof junction box for internal preamp.
22719-02	Remote weatherproof junction box without preamp, for cable extension.
22727-00	Ultrasonic cleaner with generator, 115 VAC/230 VAC 50/60 Hz, switch selectable. Includes mounting hardware and 20 feet of interconnecting cable. (For submersion service).
9200160	Extension cable, sensor or remote preamp to analyzer, 4 conductor, 22 AWG, shielded (Specify length).
22811-00	Flow cell with electrode shroud.
22892-00	Flow powered cleaner retrofit kit (for use with Code 03 sensors).

SECTION 4.0

ULTRASONIC CLEANER

4.1 ULTRASONIC CLEANER (P/N 22727-00). This accessory provides an ultrasonic cleaner and mounting hardware for either continuous or inter-mittent cleaning of the measuring electrode and liquid junction on the Model 381. The information in the following paragraph is supplemental to the information in Sections 1.0 thru 3.0.

4.2 SPECIFICATIONS. The ultrasonic cleaner operates on either 115 Vac or 230 Vac, 50/60 Hz. The mode is jumper selectable within the generator enclosure. The generator is shipped in the 115 Vac configuration.

4.3 INSTALLATION. The ultrasonic generator is shipped with special cushioning material. Before opening the container or removing any packing material, all items should be inspected for any possible shipping damage. If any damage is found, the carrier should be notified. Check the generator enclosure for damage to the finish; loosen the door clamps and inspect the circuit board and components. If there is apparent damage, contact the carrier for instructions. The packing container and cushioning material should be retained should it ever become necessary to return the generator to the factory. Install the ultrasonic cleaner as follows:

1. **Mechanical Installation.** Although the generator is designed to be located in a process environment, corrosive atmospheres and excessive vibration should be avoided if possible. The ultrasonic transducer is shipped loose along with mounting hardware and mounting instructions. Check to make certain all connections are secure. Refer to Figure 4-1 and 4-2 for mounting dimensions and select a convenient location for the generator.
2. **Electrical Installation.** An external line switch should be installed to disconnect power from the generator for maintenance or periods of non-use. Apply input power (refer to Figure 4-2) as follows: Ground to TB1-8, hot to TB1-6, and neutral to TB1-7.

CAUTION

Make sure the 115/230 jumpers on the transformer are in the proper position for the supply voltage being used. The generator will be seriously damaged if 230 Vac is supplied with the jumpers in the 115 Vac position.

The power output is approximately 1400 volts at 0.002 amp, at a frequency of 40 to 45 kHz. The transducer is supplied with 20 feet of interconnecting cable in a polypropylene protective sheath. Output connections are made at TB1-4 for R.F. (+) and TB1-2 for RF(-). Make sure the AC power line ground is properly connected to the generator's input terminals.

CAUTION

Do not run any ultrasonic cleaner power, wiring input or output, in the same conduit as the signal wiring from the sensor.

4.4 OPERATION. Submerge the sensor into sample and start the sensor as instructed in Section 2.0. After measuring system is in operation, apply AC power to the ultrasonic cleaner. Over a period of time (usually several days), gradually increase the gain until the power setting is sufficient to keep the electrodes free of process buildup.

CAUTION

Increase gain slowly and apply only the necessary amount of power. Excessive power may damage the electrode. Once initial start-up is complete, further adjustment or calibration is not normally required unless there are drastic changes in the composition of the process sample.

4.4 Operation (continued)

NOTE

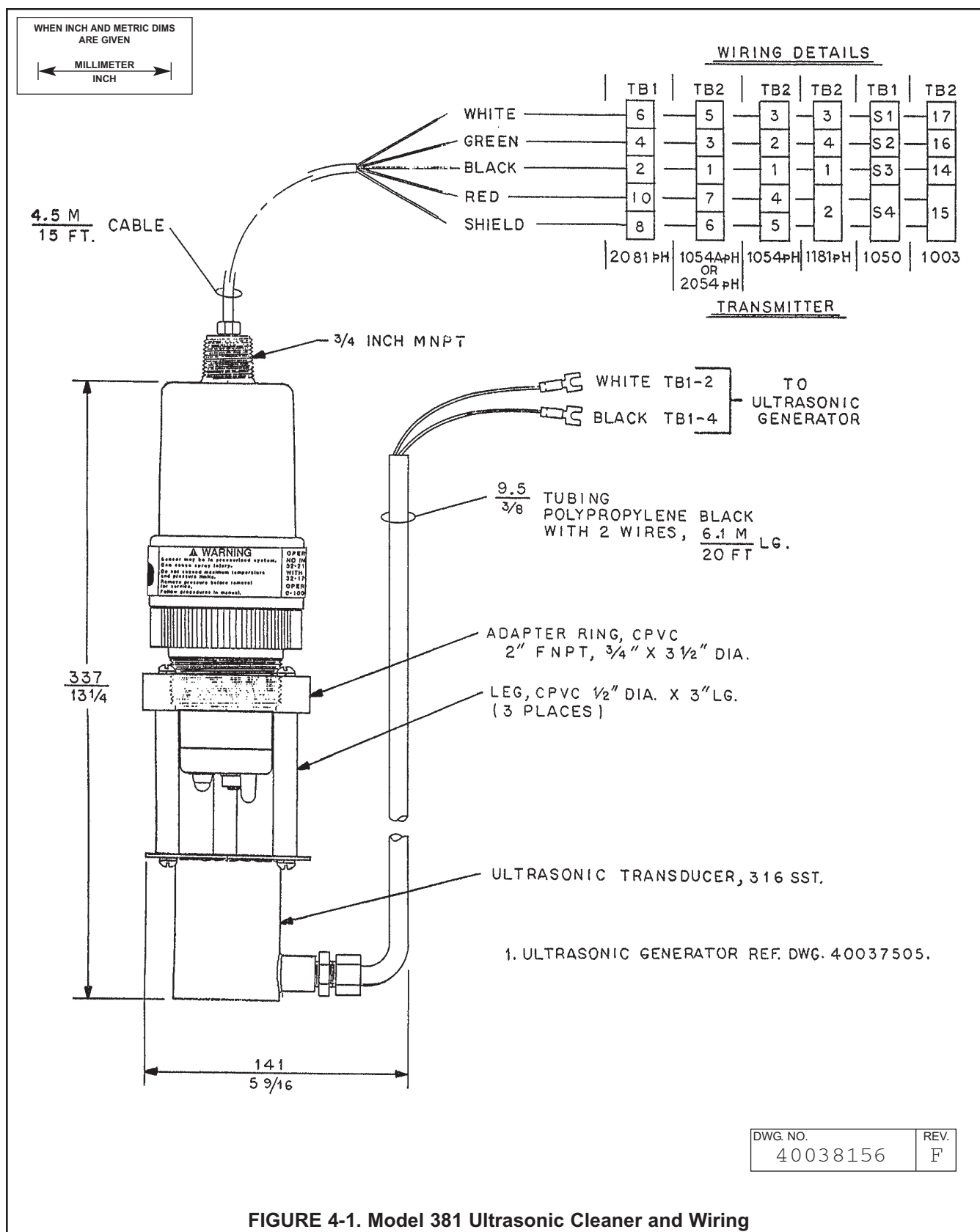
When the ultrasonic cleaner is used on some slurry applications (such as carbonates and phosphates), continuous ultrasonic cleaning is not recommended as this may tend to compact the solids of the slurry on the electrode into a hard, cement like coating. Instead, it is recommended that a shock-type treatment be applied (i.e., for every three hours of operation, employ 30 minutes of ultrasonic cleaning). The interval and duration of the cleaning, as well as the power setting utilized, are determined by the individual application. Factors such as the concentration of carbonates or phosphates, flow velocities, temperature, etc., must all be considered.

1. Output Power Adjustment. The output power adjustment on the ultrasonic generator is located on the powerstat. The powerstat is adjusted with the knob marked as PS: (Refer to Figure 4-2), and determines the cleaning efficiency of the unit by adjusting the power input of the generator. Proper adjustment is made by turning the powerstat knob counter-clockwise (minimum power position) and gradually increasing the power, by turning the knob clockwise, until the power is sufficient to keep the electrode clean. This is usually accomplished over a period of several days.

4.5 MAINTENANCE. The ultrasonic cleaner should operate continuously (with the exception of carbonate and phosphate slurries) and requires no maintenance, calibration, or adjustment, except that the power adjustment should be as low as possible consistent with good cleaning action. The ultrasonic transducer is completely sealed and should not be operating while troubleshooting the sensor or transmitter.

1. Troubleshooting. In case problems arise in the functioning of either the generator or the transducer, the entire assembly should be returned to the factory for servicing. No electronic repair work of any kind should be attempted in the field, or the warranty will be voided. Whether the unit is still under warranty or not, field troubleshooting is not recommended, and Rosemount Analytical cannot be liable for operation or safety of equipment that has been repaired or modified by persons other than its factory or their trained and authorized Field Engineers. If your unit's warranty has expired, and field troubleshooting is still desired, waveforms, frequency and voltages can be obtained directly from Branson Ultrasonic, Eagle Road, Danbury, CT 06810, (203) 796-0400. The circuit is fundamentally identical for both the old and new version.

4.6 REPLACEMENT PARTS. The ultrasonic generator may be ordered as a unit (P/N 22990-00). The ultrasonic transducer is a sealed unit and cannot be conveniently repaired in the field. While it is not likely that the transducer will fail electrically or mechanically, certain process streams may contain corrosive compounds which, in time could attack and ultimately destroy the 316 Stainless Steel faceplate. The number of spare transducers (P/N 2001463) needed on hand as replacement stock, should be determined on an individual basis, with regard to specific application conditions.



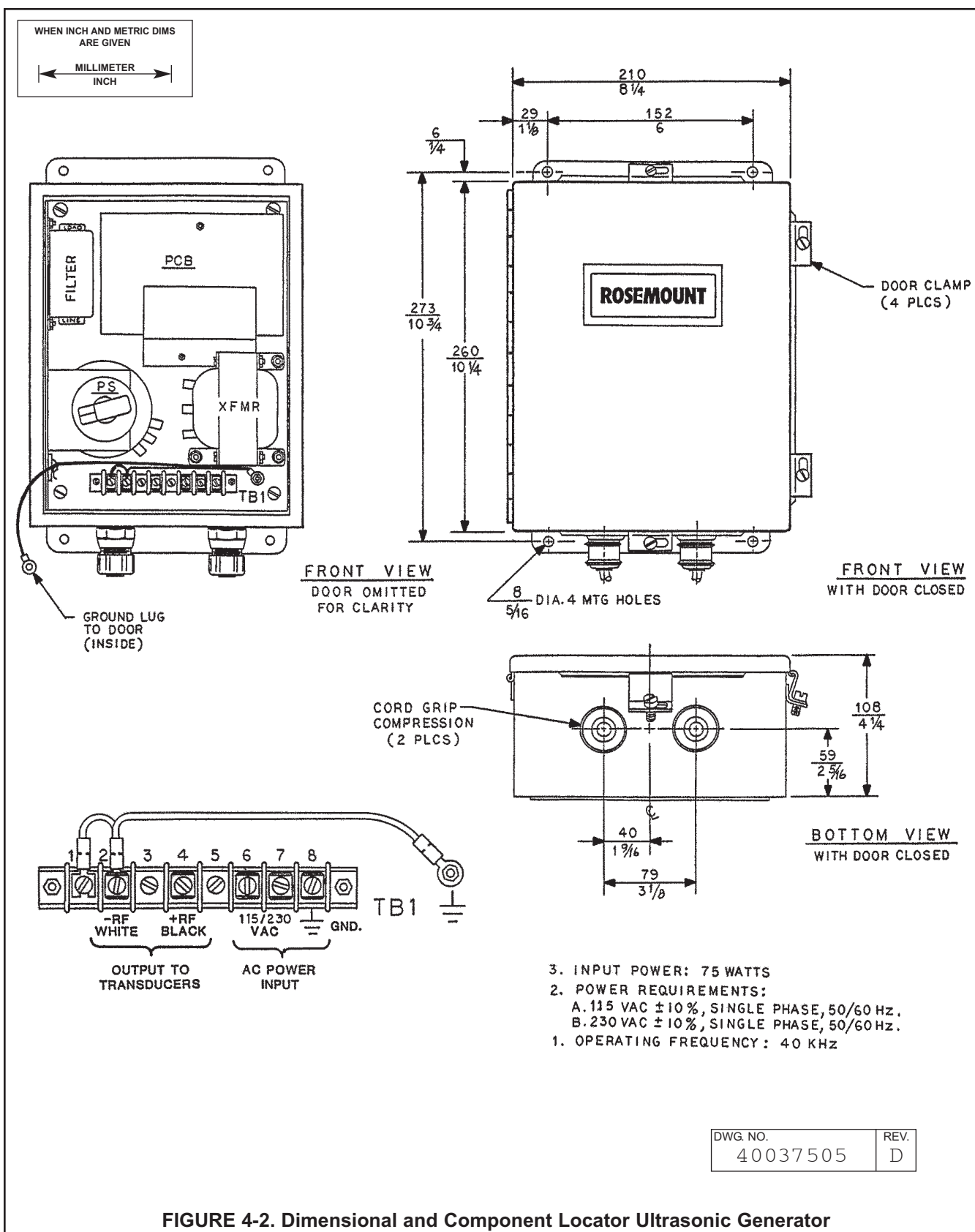


FIGURE 4-2. Dimensional and Component Locator Ultrasonic Generator

SECTION 5.0

RETURN OF MATERIAL

5.1 GENERAL. To expedite the repair and return of instruments, proper communication between the customer and the factory is important. The "Return of Materials Request" form is provided for you to copy and use in case the situation arises. The accuracy and completeness of this form will affect the processing time of your materials. Call 1 (949) 757-8500 for a Return Materials Authorization (RMA) number.

5.2 WARRANTY REPAIR. The following is the procedure for returning instruments still under warranty.

1. Contact the factory for authorization.
2. Complete a copy of the "Return of Materials Request" form as completely and accurately as possible.
3. To verify warranty, supply the factory sales order number or the original purchase order number. In the case of individual parts or sub-assemblies, the serial number on the unit must be supplied.
4. Carefully package the materials and enclose your "Letter of Transmittal" and the completed copy of the "Return of Materials Request" form. If possible, pack the materials in the same manner as it was received.

IMPORTANT

Please see second section of "Return of Materials Request Form". Compliance to the OSHA requirements is mandatory for the safety of all personnel. MSDS forms and a certification that the instruments have been disinfected or detoxified are required.

5. Send the package prepaid to:

Rosemount Analytical Inc.
2400 Barranca Parkway
Irvine, CA 92606

Attn: Factory Repair

RMA No. _____

Mark the package: Returned for Repair

Model No. _____

5.3 NON WARRANTY REPAIR.

1. Contact the factory for authorization.
2. Fill out a copy of the "Return of Materials Request" form as completely and accurately as possible.
3. Include a purchase order number and make sure to include the name and telephone number of the right individual to be contacted should additional information be needed.
4. Do Steps 4 and 5 of Section 5.2.

NOTE

Consult the factory for additional information regarding service or repair.

This form must be completed to ensure expedient factory service.



WARRANTY

Goods and part(s) (excluding consumables) manufactured by Seller are warranted to be free from defects in workmanship and material under normal use and service for a period of twelve (12) months from the date of shipment by Seller. Consumables, pH electrodes, membranes, liquid junctions, electrolyte, O-rings, etc. are warranted to be free from defects in workmanship and material under normal use and service for a period of ninety (90) days from date of shipment by Seller. Goods, part(s) and consumables proven by Seller to be defective in workmanship and / or material shall be replaced or repaired, free of charge, F.O.B. Seller's factory provided that the goods, parts(s), or consumables are returned to Seller's designated factory, transportation charges prepaid, within the twelve (12) month period of warranty in the case of goods and part(s), and in the case of consumables, within the ninety (90) day period of warranty. This warranty shall be in effect for replacement or repaired goods, part(s) and consumables for the remaining portion of the period of the twelve (12) month warranty in the case of goods and part(s) and the remaining portion of the ninety (90) day warranty in the case of consumables. A defect in goods, part(s) and consumables of the commercial unit shall not operate to condemn such commercial unit when such goods, parts(s) or consumables are capable of being renewed, repaired or replaced.

The Seller shall not be liable to the Buyer, or to any other person, for the loss or damage, directly or indirectly, arising from the use of the equipment or goods, from breach of any warranty or from any other cause. All other warranties, expressed or implied are hereby excluded.

IN CONSIDERATION OF THE STATED PURCHASE PRICE OF THE GOODS, SELLER GRANTS ONLY THE ABOVE STATED EXPRESS WARRANTY. NO OTHER WARRANTIES ARE GRANTED INCLUDING, BUT NOT LIMITED TO, EXPRESS AND IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

RETURN OF MATERIAL

Material returned for repair, whether in or out of warranty, should be shipped prepaid to:

**Rosemount Analytical Inc.
Uniloc Division
2400 Barranca Parkway
Irvine, CA 92606**

The shipping container should be marked:

Return for Repair

Model _____

The returned material should be accompanied by a letter of transmittal which should include the following information (make a copy of the "Return of Materials Request" found on the last page of the Manual and provide the following thereon):

1. Location type of service, and length of time of service of the device.
2. Description of the faulty operation of the device and the circumstances of the failure.
3. Name and telephone number of the person to contact if there are questions about the returned material.
4. Statement as to whether warranty or non-warranty service is requested.
5. Complete shipping instructions for return of the material.

Adherence to these procedures will expedite handling of the returned material and will prevent unnecessary additional charges for inspection and testing to determine the problem with the device.

If the material is returned for out-of-warranty repairs, a purchase order for repairs should be enclosed.



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